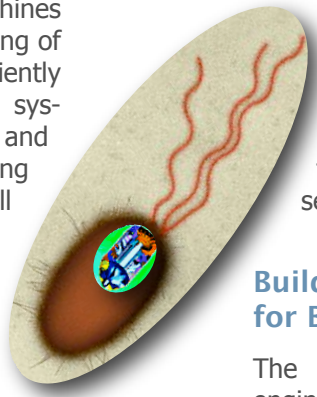
iGEM 2007 @ The University of Calgary

Designing New Biological Systems

At the world's foremost centres of learning, a revolutionary science is taking shape. The core idea of **Synthetic Biology** is to draw on knowledge developed in biology and to apply design principles used in engineering and software programming. It is now possible to create bio-synthetic systems to achieve novel applications with unprecedented power and efficiency. Research on genetically engineered machines could lead us to a greater understanding of how life functions, and how to efficiently use the very fabric from which living systems are created – DNA, proteins and cells. The possibilities of this emerging technology are almost endless, and will see applications in many areas, such as health, energy, the environment or material and manufacturing sciences. This is Synthetic Biology!

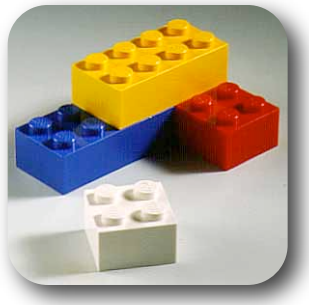


An International Competition for Bio-Engineering & Design

The **international Genetically Engineered Machines** (iGEM) competition was introduced in 2004. It built upon the foundations of a summer course at the Massachusetts Institute of Technology (MIT) in Cambridge, MA. A collection of standard interchangeable parts — called **BioBricks** — was made available to five teams of students from universities across the United States. The challenge was to design and test a simple biological system from these BioBricks, and to operate it in living bacterial cells. Designs ranged from detection of caffeine levels to implementing bacterial photographic film that could capture images with a resolution of up to 1 gigapixel per square inch!

Since its early start, iGEM has grown. In 2006, the competition included 37 schools world-wide. This expansion of the competition provides fertile ground to share experiences and knowledge among institutes, as well as link undergraduate, graduate and postgraduate studies. The highlight of the competition is its annual Jamboree, a symposium held at MIT, in November, which is a unique opportunity for the students and their supervisors to interact and present their results.

Building Blocks for Biology



The concept of an engineered BioBrick system has led to new representations of biological systems and their regulatory units based on logic gates and their associated truth tables. The resulting schematics are the direct analogue of electronic circuit diagrams. From a technological perspective, this module-based approach holds the promise of using sub-cellular modules in different combinations and utilize them for different purposes other than those within natural systems. The long-term vision is to develop a new area in which engineered BioBrick components will be used as versatile building blocks with standardized functionalities and input-output interfaces, to form technological systems not unlike those of VLSI electronics today.

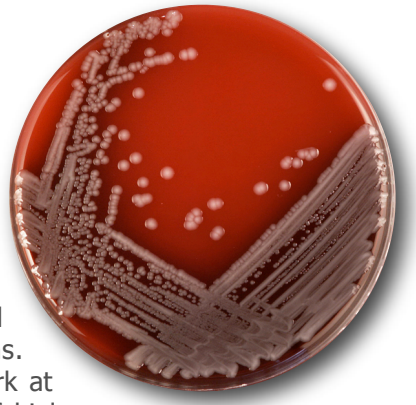
Unique Educational Opportunities

Clear separations between the disciplines of mathematics, physics, computer science and engineering are starting to vanish. Biologists are now entering the equation. iGEM brings together talented and highly motivated students and supervisors within a university, creating a unique, inquiry-based learning environment for all members on the team. Through joint problem solving and design, students are applying their personal skills to new areas and — as a welcome side effect — learn about other fields. For example, the computer scientists acquire skills needed in a wet lab, whereas biologists learn about computational modeling of complex systems.

A Biologist's View

This field is extremely exciting for biologists as it is a completely different approach compared to traditional research methods. By treating biological systems as a series of interlocking parts and using engineering approaches to design systems, synthetic biology presents a very quick way to discover what is and isn't possible in biological systems. As biology students we spend a great deal of time studying micro-

organisms, but by taking part in iGEM we gain a whole new viewpoint. By looking at how we can manipulate these systems, and by testing the limits of what is possible we can see a completely new way to study biology — and one with very obvious commercial applications.



A Computer Scientist's View

As computer scientists we follow our natural desire to design and build complex systems. With iGEM we work at the intersection of biology and software engineering. Wet lab techniques and procedures, we will familiarize ourselves with over the course of the iGEM project, will prove invaluable for our future explorations of, say, unconventional computing, and give us practical experiences that are second to none. The iGEM project will build and expand on innovative engineering modules from synthetic biology, relevant for future initiatives in biological engineering. The opportunity to investigate design ideas, as well as model and test our team's entry will be really exciting and give us a chance to acquire hands-on experiences with complex adaptive systems in Nature and learn about their designs. Building and maintaining highly complex systems is at the core of modern computer science. Our ability to systematically approach problem solving and data analysis in combination with our mathematical and programming skills will be valuable contributions to our iGEM team.

iGEM @ The University of Calgary

Nestled in the foothills of the Rocky Mountains, the University of Calgary is home to a diverse group of researchers. Innovative research that combines both Science and Medicine flourishes in multiple institutions on our campus.

The University of Calgary iGEM Team consists of students from the Evolutionary & Swarm Design Lab and Database Lab in the Department of Computer Science, students from the Department of Biological Sciences, students from the Bachelor of Health Sciences undergraduate program, as well as high school students.

iGEM@UofC 2007 Team Members

Graduate students:

Chris Jarabek (CPSC), Mohammed Salshal (CPSC), Sebastian von Mammen (CPSC)

Undergraduate students:

Dave Curran (BHSc), Patrick King (BHSc), Vladislav Lavrovsky (BHSc), Kevin McLeod (BHSc), Scott McLeod (Biology), Vladimir Sarpe (BHSc), Boris Shabash (BHSc)

High school students:

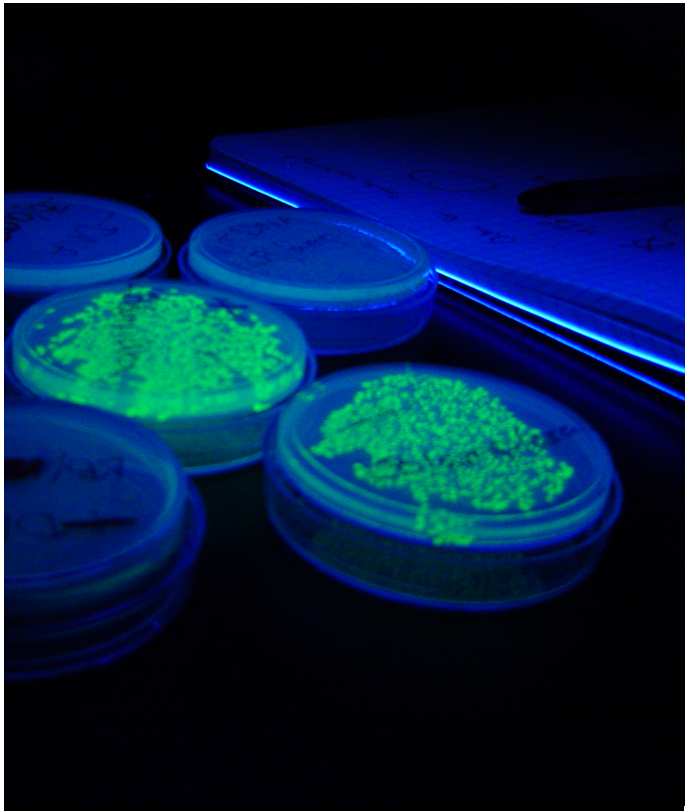
David Zhou, Harry Zhou

Supervisors:

Dr. Christian Jacob, Dr. Anthony Schryvers
Sonja Georgijevic

We gratefully acknowledge our sponsors:

Alberta Ingenuity Fund, Bachelor of Health Sciences, Department of Computer Science, Faculty of Science, Natural Sciences and Engineering Research Council of Canada.



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